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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 10/500,005
Filing Date: February 14, 2005
Appellant(s): DONOHUE ET AL.

Steven P. Weihrouch
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 8/18/09 appealing from the Office action mailed 3/18/09.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

No evidence is relied upon by the examiner in the rejection of the claims under appeal.

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

3. Claims 1-6, 8-9, 12-15 and 23-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Flamm (US 5,711,849) in view of Gerrish (US 5,770,922).

As to claim 1, Flamm discloses a method of material processing, the method comprising:

- Characterizing a process, said characterizing comprising identifying a signature of said process (abstract: method of obtaining a desired etch profile for a substrate);

- Wherein said signature comprises at least one spatial component (col 13 lines 45-52: etch rate profile determined and plotted (fig. 9) as rate vs radial distance from center of substrate);
- Optimizing said process, said optimizing comprising identifying a reference signature, comparing said signature of said process with said reference signature (Figure 4: varying temperature and pressure to obtain desired etch rate verse effective area);
- Wherein said comparing comprises determining a difference signature representing a difference between the measured and reference signatures (Figure 5: comparing etch rate (315) to desired uniformity (301)); and
- Determining a process fault by comparing said difference signature with a threshold, wherein said process fault occurs when said threshold is exceeded (Fig. 5: step 315 – determine if the etch rate is too low and changing the process if so; col 9 lines 1-10: calculation of desired uniformity using minimum and maximum desired etch rates).

Flamm, while discloses the use of Fourier analysis of the collected data (col 14 lines 51-54), is silent as to the actual conversion of the data into spectral space.

Gerrish discloses a method of analyzing data collected from a plasma processing apparatus (abstract). Gerrish discloses the conversion of collected data, by fast Fourier transform operation, into spectral data for analysis and calculation useful in control of the plasma process (col 3 lines 45-66).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to convert the data collected into spectral space, as disclosed by Gerrish, in the feedback control method of Flamm, because spectral data analysis can be used for accurate control of plasma operations.

As to claim 2, Flamm discloses said performing the process on a substrate (abstract: method involves etching of a substrate).

As to claim 3, Flamm discloses said substrate is a wafer or LCD (col 12 line 61: example using a circular substrate (wafer); col 13 line 67: calculations using LCD as substrate).

As to claim 4, Flamm discloses the process performance parameter is etching rate (abstract: determining etch rate for the process).

As to claim 5, Gerrish discloses the transforming comprises applying a discrete Fourier transform to the measured data (col 3 line 57: fast Fourier transform operation performed).

As to claim 6, Flamm discloses characterizing the relation between the signature and controllable process parameters comprises multivariate analysis (col 8 lines 57-60: etch parameters include reactor dimension, pressure, temperature and other parameters).

As to claim 8, Flamm does not explicitly state that the multivariate analysis involves design of experiment. However, design of experiment is defined as an information gathering exercise with variation of controlled parameters. Flamm, as illustrated in figures 4 and 5, is attempting to obtain a desired etch rate profile by varying

effective substrate area, temperature, and pressure. Therefore, Flamm is inherently engaged in a design of experiment analysis of multiple variables.

As to claim 9, Flamm discloses the controllable process parameter as pressure, temperature, gas flow rate, and RF power (col 1 lines 55-57: selection of temperature, pressure, gas flow rate, and RF power to obtain desired etch profile).

As to claim 12, Flamm discloses the measuring comprises obtaining a multi-dimensional scan of data (claim 4: spatial coordinate includes an x and y-direction).

As to claim 13, Flamm discloses the multi-dimensional scan of date is a two-dimensional scan of data (claim 4: spatial coordinate includes an x and y-direction).

As to claim 14, Flamm discloses a system for material processing comprising:

- A process chamber (abstract: plasma processing apparatus);
- Device for measuring and adjusting at least one controllable process parameter (Fig. 2: showing apparatus with flow, temperature and pressure controller);
- Device for measuring at least one process performance parameter, and controller (col 4 lines 25-27; figure 2: temperature, pressure and flow controllers);
- A controller capable of characterizing a process, said characterizing comprising identifying a signature of said process (col 13 lines 45-52: etch rate profile determined and plotted (fig. 9) as rate vs radial distance from center of substrate);
- Wherein said signature comprises at least one spatial component

- Optimizing said signature of said process with said reference signature for the process (Figure 4: varying temperature and pressure to obtain desired etch rate verse effective area);
- Wherein said comparing comprises determining a difference signature (Figure 5: comparing etch rate (315) to desired uniformity (301)); and
- Determining a process fault by comparing said difference signature with a threshold, wherein said process fault occurs when said threshold is exceeded (Fig. 5: step 315 – determine if the etch rate is too low and changing the process if so; col 9 lines 1-10: calculation of desired uniformity using minimum and maximum desired etch rates).

Flamm, while discloses the use of Fourier analysis of the collected data (col 14 lines 51-54), is silent as to the actual conversion of the data into spectral space.

Gerrish discloses a method of analyzing data collected from a plasma processing apparatus (abstract). Gerrish discloses the conversion of collected data, by fast Fourier transform operation, into spectral data for analysis and calculation useful in control of the plasma process (col 3 lines 45-66).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to convert the data collected into spectral space, as disclosed by Gerrish, in the feedback control method of Flamm, because spectral data analysis can be used for accurate control of plasma operations.

As to claim 15, Flamm discloses the process chamber is an etch chamber (abstract).

As to claims 23 and 24, both Flamm and Gerrish are directed towards a method and apparatus for measuring data within a plasma chamber, analyzing the data, and providing feedback to control the given process. Flamm discloses the control of RF power and pressure and temperature (as discussed above, figure 5). Each of these variables measured and controlled is inherently either global or local [temperature is a local variable, pressure is a global variable, etc].

4. Claims 1-5, 10-15 and 23-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farber (US 6,232,134, as cited in IDS) in view of Gerrish (US 5,770,922).

As to claim 1, Farber discloses a method of material processing, the method comprising:

- Characterizing a process, said characterizing comprising identifying a signature of said process (abstract: wafer processing involving measuring of surface charge distribution);
- Wherein said signature comprises at least one spatial component (Figs 2-4: charge distribution measured as circular gradient);
- Optimizing said process, said optimizing comprising identifying a reference signature, comparing said signature of said process with said reference signature (Fig. 1: steps 108 and 110: comparing measure surface charge distribution with known distribution and evaluate process based on results);

- Wherein said comparing comprises determining a difference signature (col 6 lines 29-34: determination of difference between measured and desired distribution); and
- Determining a process fault by comparing said difference signature with a threshold, wherein said process fault occurs when said threshold is exceeded (col 6 lines 33-37: comparison either within tolerable range or outside tolerable range).

Farber, while disclosing the collection and analysis of current density data, is silent as to the actual conversion of the data into spectral space.

Gerrish discloses a method of analyzing voltage or current data collected from a plasma processing apparatus (abstract). Gerrish discloses the conversion of collected data, by fast Fourier transform operation, into spectral data for analysis and calculation useful in control of the plasma process (col 3 lines 45-66).

As to claim 2, Farber discloses said performing a process comprises processing a substrate (abstract: method involves processing of a wafer).

As to claim 3, Farber discloses said substrate is a wafer (abstract: processing of a wafer).

As to claim 4, Farber discloses the process performance parameter is the film property (abstract: determining surface charge distribution pattern on wafer).

As to claim 5, Gerrish discloses the transforming comprises applying a discrete Fourier transform to the measured data (col 3 line 57: fast Fourier transform operation performed).

As to claim 10, Farber discloses the improvement comprises an improvement of spatial uniformity of the scan of data (col 10 lines 35-40; fig. 6: showing process of comparing measured charge distribution (650) with desired distribution (630) and output 660 to alter process if a problem is present).

As to claim 11, Farber discloses a minimization of at least on spatial component (col 10 lines 35-40; fig. 6: showing process of comparing measured charge distribution (650) with desired distribution (630) and output 660 to alter process if a problem is present. The process minimizes the difference between the measured and desired distribution upon visual scanning).

As to claim 12, Farber discloses the scan of data is a multidimensional scan of data (Figs 2-4: showing surface charge distribution as a 2-d graphical plot).

As to claim 13, Farber discloses the multidimensional scan of data is a two-dimensional scan of data (Figs 2-4: showing surface charge distribution as a 2-d graphical plot).

As to claim 14, Farber discloses a system for material processing comprising:

- A process chamber (col 3 lines 48: processing in a chamber);
- Device for measuring and adjusting at least one controllable process parameter (col 10 lines 35-37: adjusting process operations being performed);
- Device for measuring at least one process performance parameter, and controller (col 10 lines 21-24 and 35-37: measuring charge distribution and adjusting process operations being performed);

- Said controller capable of characterizing a process, said characterizing comprising identifying a signature of said process (abstract: wafer processing involving measuring of surface charge distribution; col 7 line 57 to col 8 line 5: process characterized with etch rate, selectivity, etc.);
- Wherein said signature comprises at least one spatial component (Figs 2-4: charge distribution measured as circular gradient);
- Optimizing said signature of said process with said reference signature for the process (Fig. 1: steps 108 and 110: comparing measure surface charge distribution with known distribution and evaluate process based on results);
- Wherein said comparing comprises determining a difference signature (col 6 lines 29-34: determination of difference between measured and desired distribution); and
- Determining a process fault by comparing said difference signature with a threshold, wherein said process fault occurs when said threshold is exceeded (col 6 lines 33-37: comparison either within tolerable range or outside tolerable range).

Farber, while disclosing the collection and analysis of current density data, is silent as to the actual conversion of the data into spectral space.

Gerrish discloses a method of analyzing voltage or current data collected from a plasma processing apparatus (abstract). Gerrish discloses the conversion of collected

data, by fast Fourier transform operation, into spectral data for analysis and calculation useful in control of the plasma process (col 3 lines 45-66).

As to claim 15, Farber discloses the process chamber is an etch chamber (col 3 lines 38-40).

As to claims 23 and 24, both Farber and Gerrish are directed towards a method and apparatus for measuring data within a plasma chamber, analyzing the data, and providing feedback to control the given process. Farber discloses the determination of an etch rate by measuring a charge distribution and feedback control of power, gas pressure and wafer position in the chamber. Each of these variables measured and controlled is inherently either global or local [charge distribution and temperature are local variables; pressure is a global variable, etc].

5. Claim 7 and 10-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Flamm in view of Gerrish, as applied to claims 1 and 6 above, and further in view of Angell (US 5,658,423).

As to claim 7, Flamm and Gerrish are silent as to the use of principal component analysis.

Angell discloses a method of monitoring an etching process, comparing measured data to a reference model, and taking corrective actions to fix any failures (abstract). Angell also discloses the use of principal component analysis to analyze multi-dimensional process data (col 4 lines 21-25). This analysis technique is disclosed

as allowing for catastrophic faults to be reliably detected with simple calculations (col 4 lines 42-46).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use principal component analysis, as disclosed by Angell, in the method of material processing of Flamm, because it allows for simple calculations to reliably detect process faults.

As to claim 10, Flamm and Gerrish are silent as to an improvement comprising the spatial uniformity of a scan of data.

Angell discloses the improvement to the process involves an increase in the spatial uniformity of a scan of data (Fig. 5: showing a sample spectral graph of measured and desired spectra [overlaid]; col 8 lines 7-15: observation of fault in figure 5 will allow corrective actions to be taken). The use of overlaid spectrum for visually identifying non-uniform data is disclosed as allowing for a monitoring system allowing interpretation by operators who are not experts (col 4 lines 32-35).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to improve spatial uniformity of scan data, as disclosed by Angell, in the method of material processing of Flamm, because it allows for non-expert operators to interpret potential faults.

As to claim 11, Angell discloses the improvement comprises a minimization of the spatial components (Fig. 5: col 8 lines 7-15: adjustments to process made in order to obtain identical overlay of measured and desired spectra).

6. Claims 16-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Flamm in view of Gerrish, as applied to claim 14 above, and further in view of Scott (US 5,601,869).

As to claims 16-22, Flamm and Gerrish are silent as to the use of a CVD or PVD chamber, a photoresist coating chamber, a spin-on-dielectric system, a photoresist patterning chamber, a UV lithography system, a rapid thermal processing chamber, or a batch diffusion furnace.

As to claims 16-22, Scott discloses a process of forming thin-film electrical components for use in integrated circuits (col 1 lines 23-25). Scott also discloses the use of a PVD chamber (col 8 lines 21: sputtering adhesion layer), a photoresist coating chamber (col 10 lines 63-66: sputtering of resist layers), a spin-on-dielectric system (col 10 lines 41-44: dielectric layer formed by spin on process), a photoresist patterning chamber (col 11 line 3-4: etching resist), a UV lithography system (col 11 line 11: UV exposure of photo mask), a rapid thermal processing chamber (col 10 line 20: rapid thermal processing anneal), and a batch diffusion furnace (col 8 line 57: use of diffusion furnace).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use a system for optimizing a process, as disclosed by Flamm, in the sputtering, spin-on coating, photoresist coating and patterning, lithography, diffusion furnace, and rapid thermal processing chambers of Scott because of the improvement from monitoring and adjusting the process to avoid faults and obtain the desired results.

7. Claims 16-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farber in view of Gerrish, as applied to claim 14 above, and further in view of Scott.

As to claims 16-22, and Gerrish are silent as to the use of a CVD or PVD chamber, a photoresist coating chamber, a spin-on-dielectric system, a photoresist patterning chamber, a UV lithography system, a rapid thermal processing chamber, or a batch diffusion furnace.

As to claims 16-22, Scott discloses a process of forming thin-film electrical components for use in integrated circuits (col 1 lines 23-25). Scott also discloses the use of a PVD chamber (col 8 lines 21: sputtering adhesion layer), a photoresist coating chamber (col 10 lines 63-66: sputtering of resist layers), a spin-on-dielectric system (col 10 lines 41-44: dielectric layer formed by spin on process), a photoresist patterning chamber (col 11 line 3-4: etching resist), a UV lithography system (col 11 line 11: UV exposure of photo mask), a rapid thermal processing chamber (col 10 line 20: rapid thermal processing anneal), and a batch diffusion furnace (col 8 line 57: use of diffusion furnace).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to use a system for optimizing a process, as disclosed by Farber, in the sputtering, spin-on coating, photoresist coating and patterning, lithography, diffusion furnace, and rapid thermal processing chambers of Scott because of the improvement from monitoring and adjusting the process to avoid faults and obtain the desired results.

(10) Response to Argument

On pages 6-7 of the Argument, Appellant argues that the office action does not explicitly state what element in Flamm corresponds to the measurement data.

As discussed in the above rejections, Flamm discloses measuring an etch profile across a substrate and comparing this to a desired profile to make adjustments to the chamber (abstract; figure 4). The measured etch rate is a measurement signature while the desired profile is a reference signature.

On pages 7-9 of the Arguments, Appellant argues that the combination of Flamm and Gerrish is not proper because Flamm involves measurement of etch rates while Gerrish is related to Fourier transforms of voltage and current data from a processing chamber. Appellant asserts that because Flamm and Gerrish are directed towards "separate aspects of a plasma processing chamber," a prima facie case of obviousness is not established as the references cannot be combined.

As stated by the Appellant, Flamm is directed towards an etching process in which an etch rate profile is measured across a substrate.

Gerrish is directed towards a method of analyzing data from a plasma processing apparatus (abstract). Gerrish obtains voltage and current data and performs a Fourier Transform to obtain spectral information for analysis (col 3 lines 53-63). In one example, this information is used in analysis for a plasma etching apparatus (col 4 line 67-col 5 line 3: analysis for determination of completion in an etching step).

Gerrish, however, is not relied upon for its disclosure of specific measurement data. Gerrish, as discussed in the rejection of the outstanding office action, discloses a method of data analysis in which Fourier Transforms are used to convert raw data into spectral data for further analysis. It is this teaching upon which Gerrish is relied upon to demonstrate that it is well known in the art to perform this specific data analysis technique. Gerrish teaches that Fourier Transform analysis allows for higher accuracy and allows for the data to be more easily exported and monitored remotely (col 7 lines 37-45).

Because both Flamm and Gerrish are within the same field of endeavor (plasma processing—more specifically etching) and Gerrish is relied upon not for its specific data being measured but rather the technique of conversion of the data to spectral space by a Fourier analysis, it would have been obvious to one of ordinary skill in the art at the time of the invention to use this well known beneficial data analysis technique of Gerrish, in the measurement and analysis method of Flamm, because Fourier conversion to spectral space increases accuracy and facilitates exporting and remote monitoring of the data.

On pages 9-11 of the Arguments, Appellant argues that the combination of Farber and Gerrish is not proper because Farber measures surface charge distribution while Gerrish is related to Fourier transforms of voltage and current data. Appellant asserts there is no rational basis for one of ordinary skill to combine the techniques of Gerrish to the data of Farber and therefore the combination is improper.

As stated by the Appellant, Farber is directed towards an etching process in which an surface charge distribution is measured across a substrate.

Gerrish is directed towards a method of analyzing data from a plasma processing apparatus (abstract). Gerrish obtains voltage and current data and performs a Fourier Transform to obtain spectral information for analysis (col 3 lines 53-63). In one example, this information is used in analysis for a plasma etching apparatus (col 4 line 67-col 5 line 3: analysis for determination of completion in an etching step).

Gerrish, however, is not relied upon for its disclosure of specific measurement data. Gerrish, as discussed in the rejection of the outstanding office action, discloses a method of data analysis in which Fourier Transforms are used to convert raw data into spectral data for further analysis. It is this teaching upon which Gerrish is relied upon to demonstrate that it is well known in the art to perform this specific data analysis technique. Gerrish teaches that Fourier Transform analysis allows for higher accuracy and allows for the data to be more easily exported and monitored remotely (col 7 lines 37-45).

Because both Farber and Gerrish are within the same field of endeavor (plasma processing—more specifically etching) and Gerrish is relied upon not for its specific data being measured but rather the technique of conversion of the data to spectral space by a Fourier analysis, it would have been obvious to one of ordinary skill in the art at the time of the invention to use this well known beneficial data analysis technique of Gerrish, in the measurement and analysis method of Farber, because Fourier

conversion to spectral space increases accuracy and facilitates exporting and remote monitoring of the data.

On pages 11-14 of the Arguments, Appellant argues that the combination of Flamm and Gerrish does not disclose or suggest “identifying whether a process variation is global or local based on the signature of spatial components” as required by claims 23 and 24.

The instant specification indicates that the Fourier transform into spectral space results in spectral data which in itself indicates whether a fault is global or local in nature. Paragraph 60 of the instant specification states that “changes in the amplitudes of the lower order spatial components …reflect global variations of processing parameters… and changes in the amplitudes of the higher order spatial components … reflect local variations of processing parameters…” Any analysis of the processing parameters, as would be performed by the system and method of Flamm in view of Gerrish, would therefore necessarily involve identification of faults either in the high or low end of the spectrum being analyzed which would automatically correspond to either local or global variations based upon their location in the spectrum.

It should also be noted that claim 24 requires the controller "is further capable of identifying whether a process variation is global or local..." No indication is given in the current arguments as to why the system of Flamm in view of Gerrish would not be capable of making this determination.

On pages 15-16 of the Arguments, Appellant argues that the combination of Farber and Gerrish does not disclose or suggest “identifying whether a process variation is global or local based on the signature of spatial components.”

The instant specification indicates that the Fourier transform into spectral space results in spectral data which in itself indicates whether a fault is global or local in nature. Paragraph 60 of the instant specification states that “changes in the amplitudes of the lower order spatial components …reflect global variations of processing parameters… and changes in the amplitudes of the higher order spatial components … reflect local variations of processing parameters…” Any analysis of the processing parameters, as would be performed by the system and method of Farber in view of Gerrish, would therefore necessarily involve identification of faults either in the high or low end of the spectrum being analyzed which would automatically correspond to either local or global variations based upon their location in the spectrum.

It should also be noted that claim 24 requires the controller "is further capable of identifying whether a process variation is global or local..." No indication is given in the current arguments as to why the system of Farber, which includes a processor for data analysis and process control (figure 6), in view of Gerrish would not be capable of making this determination.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner’s answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

/J. M. B./

Examiner, Art Unit 1795

11/23/2009

Conferees:

/Nam X Nguyen/

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